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Solar Project Cost Report

IRVINE ELEMENTARY
SCHOOL
Irvine, California
April 11, 1979



U.S. Department of Energy

**National Solar Heating and
Cooling Demonstration Program**

National Solar Data Program

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SOLAR PROJECT

COST REPORT

for

IRVINE ELEMENTARY SCHOOL

IRVINE, CALIFORNIA

Prepared for
DEPARTMENT OF ENERGY
OFFICE OF ASSISTANT SECRETARY
FOR CONSERVATION AND SOLAR APPLICATIONS
NATIONAL SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

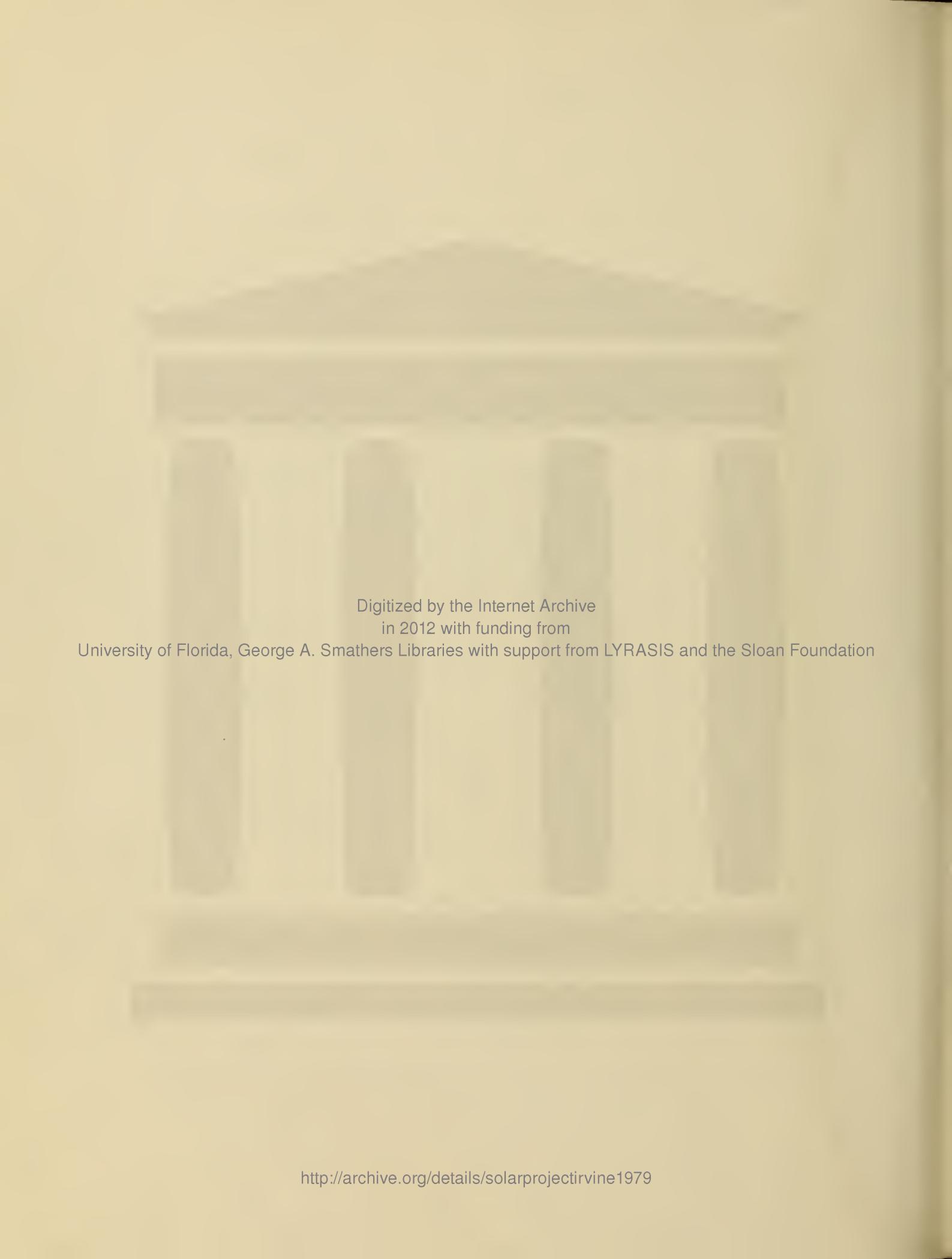
UNDER CONTRACT NUMBER

EG-77-C-01-2522

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Prepared By
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Under Subcontract to PRC Energy Analysis Company

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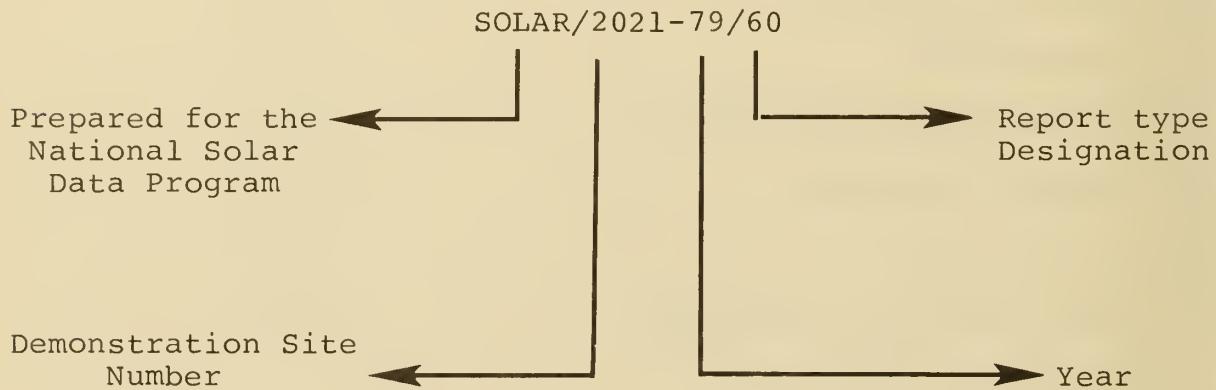
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NATIONAL SOLAR DATA PROGRAM REPORTS

Reports prepared for the National Solar Data Program are numbered under a specific format. For example, this report for the Irvine Elementary School site is designated as SOLAR/2021-79/60. The elements of this designation are explained in the following illustration:



- **Demonstration Site Number:**

Each project site has its own discrete number - 1000 through 1999 for residential sites and 2000 through 2999 for commercial sites.

- **Report Type Designation:**

This number identifies the type of report, e.g.,

- Monthly Performance Reports are designated by the numbers 01 (for January) through 12 (for December)
- Solar Energy System Performance Evaluations are designated by the number 14
- Solar Project Descriptions are designated by the number 50
- Solar Project Cost Reports are designated by the number 60

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I. FOREWORD

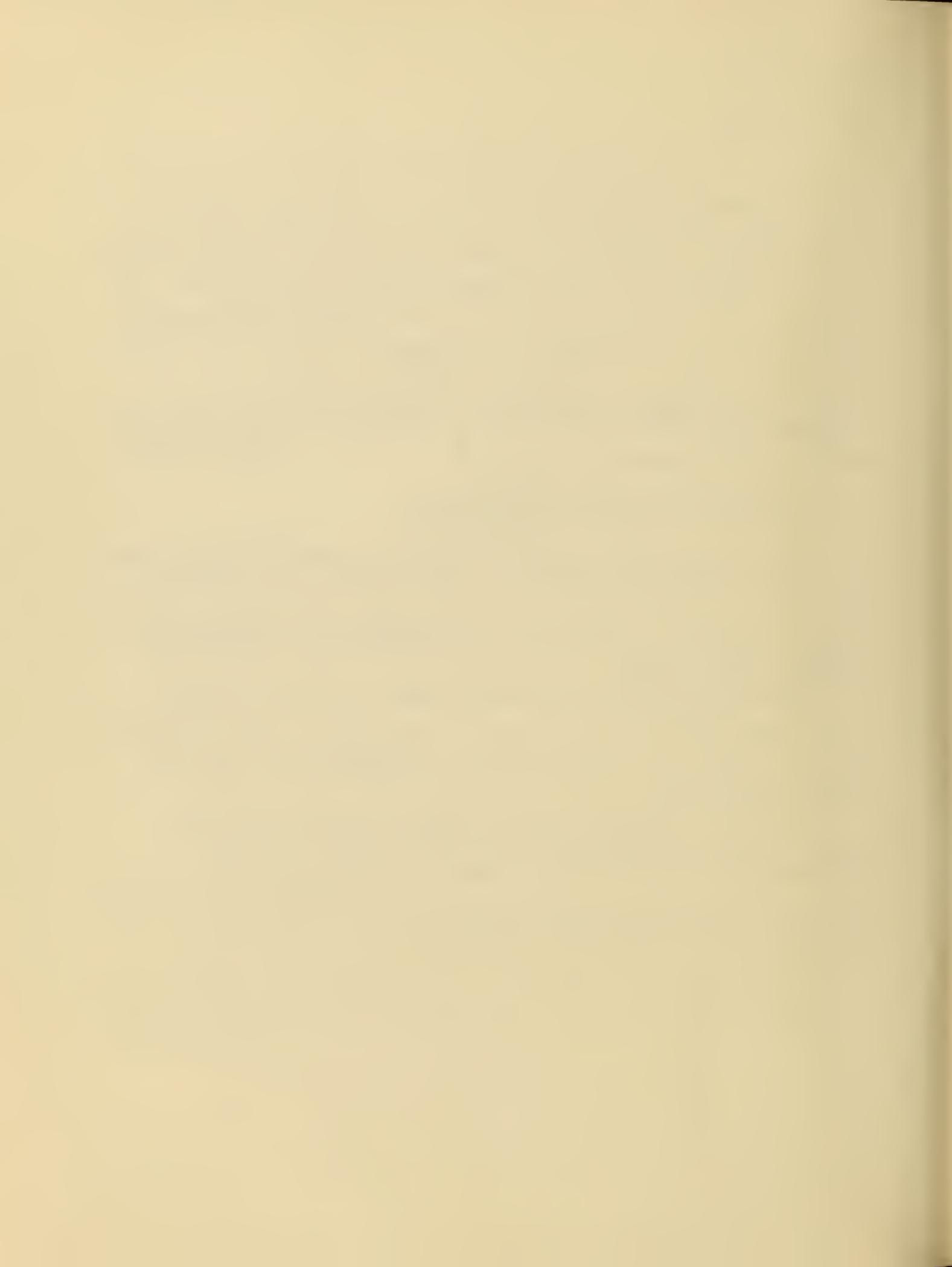
The National Program for Solar Heating and Cooling is being conducted by the Department of Energy as mandated by the Solar Heating and Cooling Demonstration Act of 1974. The overall goal of the Federal Demonstration Program is to assist in the establishment of a viable solar industry and to stimulate its growth. An analysis and synthesis of the information gathered through this program will be disseminated in site-specific reports and summary documents as part of the National Solar Data Program. This cost report is a component of a larger data gathering effort to determine the costs and cost factors to satisfy the data requirements of the following:

- DOE planning and management
- Economic projections and analysis
- The solar industry infrastructure

The focus of this report is the intital installation cost of the system. No design, start-up, operating or maintenance costs are provided nor are costs for the site data acquisition system (SDAS) and display system that may be installed in conjunction with the solar system.

Associated reports prepared by others for this specific solar demonstration project describe the system in greater detail, provide reliability and maintenance information, and describe system performance.

A similar series of reports is being developed for other solar demonstration program projects to assure widespread dissemination of project data. Detailed analysis of this report will require reference to the "Solar Project Description" for this project, report number SOLAR/2021-79/50.



II. EXECUTIVE SUMMARY

This report provides detailed cost information for the solar space heating and cooling project at El Camino Real Elementary School in Irvine, California.

This Demonstration Project was funded by the U.S. Energy Research and Development Administration (ERDA, now the U.S. Department of Energy, DOE) in the Program Opportunity Notice (PON) Cycle 1. The PON request was issued in the Autumn of 1975.

The system utilizes 180 Owens-Illinois solar collector modules. The modules, each consisting of 24 evacuated, selective surfaced tubes, provide an effective aperture area of 5,000 square feet. The collectors are mounted in 18 banks on the flat roof of the building.

No storage subsystem is provided in the system. Solar heated water is pumped directly through a heat exchanger piped in series with the existing gas fired boiler.

The construction costs of this solar space heating and cooling system are presented in this report. Category costs are listed by materials, labor, and subcontract costs. Subcontract costs include materials, labor, and overhead and profit costs and are presented only when a breakdown of these cost components could not be obtained.

The construction cost for this project was \$230,305 not including general contractor overhead and profit and general and administrative costs. Subsequent sections, especially Sections VI through IX provide a more detailed account of the data base and category cost components.

III. INTRODUCTION

The approach to assembling the data into solar system cost categories for every installation is to resolve the data into elements at two levels of detail, primary and secondary. Table III-1 provides an indication of the level of disaggregation associated with primary and secondary cost breakdowns.

TABLE III-1. SITE SPECIFIC COST BREAKDOWN

PRIMARY	SECONDARY
Collector Array	<ul style="list-style-type: none"> ● Materials ● Delivery ● Mounting on Support Structure ● Collectors Connecting to Manifold
Collector Support Structure	<ul style="list-style-type: none"> ● Materials ● Labor
Piping	<ul style="list-style-type: none"> ● Collector Distribution System <ul style="list-style-type: none"> ○ Materials ○ Labor ● Other Piping <ul style="list-style-type: none"> ○ Materials ○ Labor
Ductwork	<ul style="list-style-type: none"> ● Collector Distribution System <ul style="list-style-type: none"> ○ Materials ○ Labor ● Other Ductwork <ul style="list-style-type: none"> ○ Materials ○ Labor
Insulation	<ul style="list-style-type: none"> ● Collector Distribution System <ul style="list-style-type: none"> ○ Materials ○ Labor ● Other Piping/Ductwork <ul style="list-style-type: none"> ○ Materials ○ Labor
Heating/Cooling Equipment	<ul style="list-style-type: none"> ● Materials ● Delivery ● Installation
Storage	<ul style="list-style-type: none"> ● Materials ● Delivery ● Installation ● Insulation
Controls	<ul style="list-style-type: none"> ● Materials ● Labor
Electrical	<ul style="list-style-type: none"> ● Total
General Construction	<ul style="list-style-type: none"> ● Roofing ● Equipment Room ● Architectural ● Excavation ● Painting
TOTAL PROJECT COST	

In general, the primary cost breakdown follows work categories typically performed by different trades or subcontractors on building systems construction projects and are often separable, identifiable costs. The secondary cost categories represent a more detailed breakdown of the primary categories and are more difficult to obtain. This information is sought through discussions with subcontractors and suppliers, and by reviewing their records.

The following are typical examples of components comprising the cost breakdown categories listed on Table III-1.

- o Collector Array: all materials provided by collector manufacturer (including tracking mechanisms, attachment fittings, hoses), labor to install collectors on support structure, labor and materials to connect collectors to supply and return manifolds, and miscellaneous specialties required for a complete array.
- o Collector Support Structure: all framing, beams and columns, roof connections, fasteners and brackets required to receive collectors.
- o Piping: all collector distribution and major supply and return piping, external collector manifolds, if required pumps, expansion tanks, valves, interconnecting piping, hangers, and miscellaneous piping specialties.
- o Ductwork: all ductwork connecting collectors to air handling equipment, dampers, interconnection with auxiliary systems and filter boxes.
- o Insulation: all insulation - both interior and exterior - for piping and ductwork, chillers, and miscellaneous equipment, except energy storage containers.
- o Heating/Cooling Equipment: absorption chillers, heat pumps, and heat exchangers used to interface with auxiliary system or to deliver energy directly to load.
- o Storage: vessel or container, lining, supports, pads, internal piping, nozzles, and insulation.

- o Controls: solid state controllers, thermostats, alarms, switches, wiring, automatic valves and miscellaneous pneumatic or electrical devices.
- o Electrical: normally an identifiable subcontract including power wiring, motor controllers, starters, conduits, disconnect switches, and miscellaneous high voltage electrical devices.
- o General Construction: excavation, crane, tool and equipment rental, permits, painting, architectural modifications or additional space requirements, roofing and temporary services such as clean-up, field offices, and temporary telephone and electrical service.

Auxiliary energy system costs are not included as part of the solar energy system costs.

Obtaining accurate total project construction cost is the focus of the data gathering effort. The costs presented do not include the contractor's overhead and profit (OH&P) or general and administrative costs. There is a general sensitivity to the publication of OH&P costs among corporations in a competitive market. Also, the bare costs (without overhead and profit) are more useful to other project planners and contractors since they could include their own overhead and profit figures.

General contractors are the main source of data since they have the most cost information for each project. Major subcontractors are interviewed where possible to obtain more specific information pertaining to respective subsystems. Interviews are pursued with the personnel from the contracting firms who were actually on site performing the work and those that kept the cost records.

For each cost category the following types of information are sought:

- o Labor type utilized.
- o Number of workers utilized.
- o Number of hours required.
- o Time per unit of equipment installed.
- o Materials cost.

- o Labor rates.
- o Delivery costs of major items.
- o Overhead factors.
- o Total costs.

This information is obtained from cost files, invoices, time logs, government payment request vouchers, monthly progress reports, bills-of-materials, and the interviews.

In addition to the above data, each contractor and subcontractor is questioned concerning cost estimating techniques employed to date, recommended areas for cost reduction, final engineering cost estimates, and any other pertinent cost information.

It must be emphasized that this cost information can only be assessed in relation to the detailed system description report, Solar/2021-79/50.

IV. SYSTEM DESCRIPTION SUMMARY

The following is a brief summary of the El Camino Real School solar installation in Irvine, California. Major features of this system include:

- Collector - Evacuated, glass tube
- Freeze protection - Circulation of warm water
- Application - Heating and cooling
- Storage - None
- New/Retrofit - Retrofit
- Performance evaluation instrumentation - Yes
- Site specific features - Evacuated tubes with no storage

The El Camino Real School in Irvine, California, has a solar energy system for space heating and cooling for the 40,000 square foot school building. Since heating demands are low due to the moderate climate and most of the load demand occurs during the day, no solar energy storage is provided.

The 5,000 square feet of Owens-Illinois evacuated tubular glass collectors face south at a 25° angle to the horizontal. The collector modules consist of 24 tubes, 12 up and 12 down in a series flow arrangement. The modules are piped in reverse return with insulated steel branch piping.

Overheat protection is provided by a heat rejector system on the roof of the building. Freeze protection is provided by circulating water through the collectors when the ambient temperature reaches a set minimum. Space heating is provided by circulating hot water from the collectors through a heat exchanger installed upstream and in series with the existing gas-fired boiler; the energy is transferred to the load via the heat exchanger and then to seven roof-mounted air handling units. A gas-fired boiler is used for any additional heating.

Space cooling is provided by circulating hot water from the collectors through a heat exchanger installed upstream and in series with the existing gas-fired boiler; the energy in this load loop is used to power two 100-ton absorption water chillers. The chilled water from the chillers is then delivered to the chilled water coils, and the cool air is provided to the different zones via the distribution ducts.

The system has been fully instrumented for performance evaluation and integrated into the National Solar Data Network. It has been operational since September 1978.

V. PROJECT BACKGROUND

The Irvine Elementary School Solar Project was constructed as a result of a proposal to ERDA by the Irvine, California, Unified School District in November 1975. The contract with ERDA, which committed the Government to fund 70% of the estimated project cost was awarded in April 1976. Construction of the system began in June 1977 and was essentially completed by April 4, 1978, when opening day ceremonies were held. Acceptance testing was completed in September 1978.

The project was organized as follows:

- Owner - Irvine Unified School District
- Architect - Porter-Jensen-Hansen-Manzagol, Architects
- Mechanical Engineer - John Baum and Associates
- Solar Engineer - McCaughey & Smith Energy Associates
- General Contractor - United Air Conditioning Co.
- Subcontractors -
 - Insulation - Consolidated Western
 - Electrical - Janzen Electrical
 - Carpenter - Roy Hamilton

The majority of the installation was provided by United Air Conditioning. Subcontractors installed the insulation, collector support structure and electrical power and controls. The collectors were pre-purchased by the school district. All work was performed by union labor.

VI. DATA SOURCES

Cost data for the Irvine Elementary School solar energy system were collected during a visit to the site and the owner's offices in Irvine and the general contractor's offices in Monterey Park, California, on April 11, 1979. Telephone calls were made subsequently, to obtain some of the subcontractor's cost breakdowns.

The primary source materials were owner's records, general contractor's records, and supplier's invoices. Secondary data sources were:

- Cost component breakdown provided by Roy Hamilton.
- Discussions with a representative of United Air Conditioning.
- Discussions with a representative of Consolidated Western.
- Discussions with a representative of Janzen Electric.

VII. COST ANALYSIS BY CATEGORY

A. Introduction

In the ten sub-sections that follow, cost information is provided for the following categories of the solar system.

- Collector Array
- Support Structure
- Piping
- Ductwork
- Insulation
- Heating/Cooling Equipment
- Storage
- Controls
- Electrical Power
- General Construction

In each sub-section, descriptions of the category are presented along with the cost components. A tabular presentation of the cost data then follows. All cost data are rounded to the nearest five dollar increment. The data sources used for that category and any unique aspects are discussed along with detailed information related to the basis of the costs. This includes the identification of costs that were either unavailable or impossible to separate from the other categories.

B. Collector Array

The collector array category includes costs associated with the purchase of the collector materials, delivery, handling and mounting, and piping of the collectors on the structural frame. Costs associated with the materials and construction of the structural frame are included in the support structure category. For the Irvine project, the collector category includes collector tube modules, hose and clamps used to connect modules to piping, and delivery as materials costs, and mounting and connecting modules to piping as labor costs. Table VII-1 presents the cost breakdown for this category.

TABLE VII-1. COLLECTOR ARRAY CATEGORY COSTS - IRVINE

COMPONENT	COST, \$		
	MATERIALS	LABOR	SUBCONTRACT
Materials			
Collector modules	\$104,370		None
Hose	\$ 345		
Clamps	\$ 35		
Mount Collectors		\$4,950	
Connect Collectors to Piping		\$ 660	
Delivery	\$ 2,700		
Subtotals	\$107,450	\$5,610	None
COLLECTOR ARRAY CATEGORY TOTAL			\$113,060

- Collector Array Materials
 - Data Sources - Supplier's invoices, owner's records, discussion with Contractor personnel.
 - Cost Components - Collectors: 180 Owens-Illinois Sunpak modules.
 - High temperature, high pressure hose.
 - Clamps for above.
 - Delivery of collectors.
- Collector Mounting
 - Data Sources - Contractor records, discussion with Contractor personnel.
 - Cost Components - Collector mounting, 180 man-hours.
 - Connect to piping, 24 man-hours.

C. Support Structure

The support structure consists of wooden frames supporting plywood panels on which are mounted white painted aluminum sheets. Support structure costs are presented in Table VII-2.

TABLE VII-2. SUPPORT STRUCTURE CATEGORY COSTS - IRVINE

COMPONENT	COST, \$		
	MATERIALS	LABOR	SUBCONTRACT
Materials			
Lumber	\$10,000		None
Plywood	\$ 2,000		
Aluminum	\$ 4,000		
Laminating	\$ 1,300		
Hardware	\$ 2,000		
Labor and Supervision		\$11,300	
Subtotals	\$19,300	\$11,300	None
SUPPORT STRUCTURE CATEGORY TOTAL			\$30,600

- Materials
 - Data Source - Subcontractor records.
 - Cost Components - Lumber, plywood panel, aluminum sheets, laminating and hardware to construct 18 support assemblies.
- Labor
 - Data Source - Subcontractor records.
 - Cost Components - Labor to construct support assemblies.

D. Piping

The piping category includes piping, valves, pumps, and miscellaneous components used to transport the system fluid. Virtually all piping and fluid transport equipment is above the roof. The piping cost breakdown is provided in Table VII-3.

TABLE VII-3. PIPING CATEGORY COSTS - IRVINE

COMPONENT	COST, \$		
	MATERIALS	LABOR	SUBCONTRACT
Materials			
Pumps & expansion tank	\$ 1,960		None
Circuit setters	\$ 1,015		
Heat exchanger	\$ 3,335		
Heat rejector	\$ 1,450		
Other	\$15,075		
Labor		\$25,920	
Subtotals	\$22,835	\$25,920	None
PIPING CATEGORY TOTAL		\$48,755	

- Materials
 - Data Sources - Contractor's records, discussion with Contractor personnel.
 - Cost Components - two 140 gpm pumps
 - two 20 gpm pumps
 - expansion tank
 - shell and tube heat exchanger
 - heat rejector unit
 - piping, valves, miscellaneous components
- Labor
 - Data Sources - Contractor's records, discussion with Contractor personnel.
 - Cost Component - Labor to install energy transfer subsystem.

E. Ductwork

The ductwork category costs for the Irvine project consists of the cost incurred in moving an air handling unit on the roof in order to accommodate the collector array. The Contractor also maintained a member of the sheet metal workers union on-site to prevent any union difficulties. These two costs were not separate and are presented in Table VII-4.

TABLE VII-4. DUCTWORK CATEGORY COSTS - IRVINE

COMPONENT	COST, \$	
	MATERIALS	LABOR
Move ductwork on roof and maintain sheet metal worker	None	\$4,875
Subtotals	None	\$4,875
DUCTWORK CATEGORY TOTAL	\$4,875	

- Labor
 - Data Sources - Contractor's records, discussion with Contractor personnel.
 - Cost Components - Cost of moving air handling unit
 - Cost of maintaining sheet metal worker at site.

F. Insulation

The insulation category includes piping insulation and insulation around the heat exchanger. Costs are listed in Table VII-5.

TABLE VII-5. INSULATION CATEGORY COSTS - IRVINE

COMPONENT	COST, \$	
	MATERIALS	LABOR
Insulation for pipes and heat exchanger	\$2,065	\$4,135
Subtotals	\$2,065	\$4,135
INSULATION CATEGORY TOTAL	\$6,200	

- Materials
 - Data Source - Discussion with insulation subcontractor personnel.
 - Cost Components - Piping insulation: 1" glass-fiber, aluminum cover.

- Heat exchanger insulation: 1" glass-fiber, painted canvas cover.
- Labor
 - Data Source - Discussion with insulation Subcontractor personnel.
 - Cost Components - Labor to install piping and heat exchanger insulation and covers.

(The Subcontractor noted that the use of Victaulic pipe couplings increased the cost of insulation approximately \$2,000.)

G. Heating/Cooling Equipment

The Irvine system was a retrofit, and all heating and cooling equipment is part of the original system. No heating and cooling equipment costs are applicable to the solar energy system.

H. Storage

The Irvine system has no storage subsystem and no storage costs were incurred.

I. Controls

The controls category costs include the cost of automatic valves and materials for the control system and for a control panel. The labor cost for installation of these components could not be separated from the electrical subcontract and are included in the electrical category costs. See Table VII-6 for control costs.

TABLE VII-6. CONTROLS CATEGORY COSTS - IRVINE

COMPONENT	COST, \$	
	MATERIALS	LABOR
3-way valve	\$ 480	None
Valves, Miscellaneous Material	\$1,365	
Control Panel	\$1,680	
Subtotals	\$3,525	None
CONTROLS CATEGORY TOTAL	\$3,525	

J. Electrical Power

The electrical power costs consist of the electrical subcontract cost. This cost includes the subcontractor's labor and materials costs and overhead and profit. The cost of electrical wiring for the control system could not be separated from the electrical subcontract and is included here. See Table VII-7 for electrical costs.

TABLE VII-7. ELECTRICAL POWER CATEGORY COSTS - IRVINE

COMPONENT	COST, \$		
	MATERIALS	LABOR	SUBCONTRACT
Electrical Subcontract	None	None	\$17,950*
Subtotals	None	None	\$17,950
ELECTRICAL POWER CATEGORY TOTAL		\$17,950	

*Includes cost of wiring controls.

- Electrical Power
 - Data Sources - Contractor's record, discussion with Subcontractor personnel.
 - Cost Component - Electrical subcontract cost.

K. General Construction

The general construction category costs for the Irvine School include labor costs for truck drivers, rental of equipment, freight costs, and miscellaneous costs. Table VII-8 shows general construction costs.

TABLE VII-8. GENERAL CONSTRUCTION CATEGORY COSTS - IRVINE

COMPONENT	COST, \$	
	MATERIALS	LABOR
Truck drivers	--	\$1,235
Equipment rental	\$1,735	--
Freight	\$ 125	--
Miscellaneous	\$2,245	--
Subtotals	\$4,105	\$1,235
GENERAL CONSTRUCTION CATEGORY TOTAL		\$5,340

- General Construction
 - Data Source - General Contractor's records.
 - Cost Components - Labor cost of truck drivers
 - Equipment rental costs
 - Freight costs
 - Miscellaneous costs

VIII.TOTAL SYSTEM CONSTRUCTION COST

Table VII-1 presents the total system construction cost summary based on costs presented in Section VII. For clarity, attention is called to the fact that the materials and labor columns include the cost of materials and equipment, and direct-labor. No allowance for overhead and profit (OH&P) or general and administrative expenses (G&A) has been made. Charges for OH&P and G&A can vary significantly and are primarily important to the individual firms and specific project. Applying such charges to the data presented in Table VIII-1 is a straight-forward matter and is discussed further in Section X.

The subcontract column of Table VIII-1 includes the OH&P of the subcontractor. It was not possible to exclude the OH&P values from this column.

TABLE VIII-1. TOTAL SYSTEM CONSTRUCTION COST SUMMARY - IRVINE

CATEGORY ^a	MATERIALS	LABOR	SUBCONTRACTS	TOTAL
Collector Array	\$107,450	\$ 5,610	None	\$113,060
Support Structure	19,300	11,300	None	30,600
Piping	22,835	25,920	None	48,755
Ductwork	None	4,875	None	4,875
Insulation	2,065	4,135	None	6,200
Heating/Cooling Equipment	None	None	None	None
Storage	None	None	None	None
Controls	3,525 ^b	None	None	3,525
Electrical Power	None	None	\$17,950 ^c	17,950
General Construction	4,105	1,235	None	5,340
Subtotals	\$159,280	\$53,075	\$17,950	
TOTAL MATERIALS, LABOR AND SUBCONTRACT				\$230,305 ^d

^aFor a complete description of items included in each category, see Section VII.

^bCost of wiring controls is included in electrical power category costs.

^cIncludes the cost of wiring controls. No further breakdown could be obtained.

^dDoes not include overhead and profit or general and administrative expenses.

IX. DISCUSSION

In this section, the data are presented in formats to facilitate comparisons and further analysis of data collected at the various demonstration sites.

In Section VII, several factors affecting the representativeness of a given category's cost data are discussed. A useful method of comparing systems is to analyze the proportional composition of the total cost. It is also useful to analyze the cost data unitized by some system parameter such as collector aperture area. Table IX-1 presents the proportional composition of the total system cost and the unit category costs.

TABLE IX-1. CATEGORY COSTS PER UNIT AREA AND AS A PERCENT OF TOTAL COST - IRVINE

CATEGORY ^a	UNIT COST, \$/ft ² COLLECTOR AREA ^b		PERCENT OF TOTAL SYSTEM COST	
	BARE COSTS \$/ft ²	TOTAL COSTS INCLUDING (OH&P) ^c \$/ft ²	% TOTAL	% TOTAL (OH&P)
Collector Array	\$22.60	\$28.30	49	50
Support Structure	6.10	7.70	13	13
Piping	9.80	12.20	21	21
Ductwork	1.00	1.20	2	2
Insulation	1.20	1.60	3	3
Heating/Cooling Equipment	None	None	None	None
Storage	None	None	None	None
Controls	0.70	0.90	2	2
Electrical Power	3.60	3.90	8	7
General Construction	1.10	1.30	2	2
TOTAL SYSTEM	\$46.10	\$57.00	100	100

^aFor a complete description of items included in each category, see Section VII.

^bCosts are in 1977 dollars and rounded to the nearest \$0.10. Based on collector area of 5,000 sq. ft.

^cSee Section X for the procedure used to add overhead and profit.

The costs reported above are for the basic solar system only. As mentioned previously, the system is instrumented for data acquisition. A display unit explaining operating modes and status is also built into the system. Costs for the display and data acquisition capabilities are not included in this report because these costs should not be ascribed to the solar system. Electrical and piping subcontract costs associated with display and data acquisition are also not reported.

X. SYSTEM COST FOR USE IN ANALYSIS

Detailed performance data is being acquired for this solar energy system through the National Solar Data Network. The assessment of this system's economic performance (cost/btu) requires a total construction cost figure that should include an overhead and profit (OH&P) factor. However, a constant OH&P factor will be applied to all bare costs in these reports to remove the effect of the great variation of OH&P percentages encountered in the program.

To illustrate the problem, consider two systems. System A performs well, but was installed by a contractor with a high OH&P factor. System B does not perform as well, but was installed by a contractor with a low OH&P factor. It would not be appropriate to penalize System A in an economic performance comparison of the two systems because of the installers OH&P factor. Major variations in OH&P factors are expected due to the diversity of business firm types that contracted to install the solar demonstration systems. These include colleges and universities, engineering firms and construction contractors. The comparison discussed above represents the extremes of conditions that can be encountered.

As a result, a need exists to "normalize" the treatment of OH&P in analysis of the cost data. For this reason, an OH&P factor of 25% will be added to all bare costs (materials and labor) and 10% will be added to all subcontract costs to represent the cost that the General Contractor would charge for the system.

The equivalent total construction cost thus determined for the solar energy system in the Irvine Elementary School is \$285,190 in 1977 dollars. To allow equivalent comparisons among sites, all cost data must account for the effects of inflation. Adjustment of data from all sites to a common year will eliminate inflation biases. The year selected was 1977, thus no escalation factor is needed, since the Irvine system was constructed in that year.

Table X-1 provides a summary of total system costs using the various methods presented in this report.

TABLE X-1. SUMMARY OF TOTAL REPORT-IRVINE

TOTAL COST	TOTAL WITHOUT OVERHEAD & PROFIT	TOTAL WITH OVERHEAD & PROFIT
	\$230,305	\$285,190
\$/Sq. Ft.*	\$46.10/Sq. Ft.	\$57.00/Sq. Ft.

*Based on 5,000 Sq. Ft. collector area.

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